TELEMETRY MEASUREMENT OF SELECTED BIOLOGICAL SIGNALS BY USING BLUETOOTH TECHNOLOGY

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Summary This work treats of using the Bluetooth technology in biomedical engineering. The Bluetooth is used for transmission of measured data from pulse oximeter, ECG and monitor of blood pressure. OEM modules realize the devices for pulse oximetry and ECG. Both these realized devices can communicate with computer by Bluetooth technology and standard serial link too. The realized system of measuring devices is very flexible and mobile, because the Bluetooth technology is used and accumulators can supply the realized devices. It is possible to measure other physical values converted to voltage, because the used OEM module for pulse oximetry include A/D converter. The part of this work is software visualisation of measured values too.

Abstrakt Tato práce se zabývá možností využití technologie Bluetooth v oblastech telemedicíny a biomedicínského inženýrství. Pro přenos hodnot naměřených pulsním oxymetrem, elektrokardiogramem a monitorem krevního tlaku je využito technologie Bluetooth. Zařízení pro snímání pulsní oxymetrie a elektrokardigramu jsou z důvodu požadavku co nejmenších rozměrů realizovány pomocí OEM modulů, které se užívají v moderní lékařské technice. Oba tyto vytvořené přístroje nabízí možnost komunikace s počítačem jak po standardní seriové lince tak pomocí Bluetooth. Oba vytvořené přístroje lze rovněž napájet pomocí akumulátorů. Realizovaný systém měřících zařízení je díky technologii Bluetooth a možnosti napájení akumulátory velice flexibilní. Součástí OEM modulu pro pulsní oxymetrii je A/D převodník. Tím je umožněno měřit další fyzikální veličiny převedené na napětí, jako je například teplota. Součástí práce je také zpracování a vizualizace naměřených dat.

1. INTRODUCTION

The Bluetooth is one of the modern telecommunication technologies, which is used in many branches so often now. This young and dynamically developed technology is used in many applications, which we are using every day. It is used in mobile telecommunications, for wireless connection of computer peripheries, for wireless connections of various sensors and regulators in industry regulations.

So why don't to use this technology in biomedical engineering. This work treats of usage the Bluetooth technology in biomedical engineering. The Bluetooth technology is used for wireless transmission of some biological signals from measuring device to computer. Measuring devices including Bluetooth could be more mobile, the manipulation with these devices could be easier and there couldn't be emplacement problems. To check on possibility of usage of Bluetooth technology in biomedical engineering it was used for transmission data from blood pressure monitor, from device for pulse oximetry and ECG data.
Cable replacement is benefit for user. User get more comfort, the manipulation with device is easier. The device is more flexible and more useable. There is the possibility to create wireless network set up from more devices. It is possible to communicate with notebooks, PDA or mobile phones.

2. MATERIALS AND METHODS

It was used OEM modules from refurbished produces for measure. Such OEM modules are often included in many diagnostics devices. Because such OEM modules are created for using at built-in systems, it was necessary to solve problems with power supply and optimize communication interface to can those OEM modules communicate with computer by standard serial interface or by Bluetooth. There was for both selected OEM modules designed and realized circuits for power supply stabilization, circuits for conversion communication interface of modules to RS232 standard and circuits which allow connections with modules for realize Bluetooth connections.

The first chose OEM module is OEM module named ChipOx from EnviteC Company. ChipOx is a pulse oximeter module for the non-invasive determination of the functional oxygen saturation in human arterial blood (SpO2) and for measuring the pulse frequency. ChipOx has very small dimensions (31mm x 14mm x 5mm), which allows it to be easily installed in medical products. It also has low energy consumption, is equipped with ESD and EMC protection and can be easily mounted on a carrier printed circuit board (host PCB).

ChipOx offers 3 inputs with maximal input voltage 2400 mV for the measurement of other parameters, which are each sampled with a maximum of 100 Hz, 12 Bits.

The sampling rate and the input voltage ranges are freely configurable over the communication protocol.

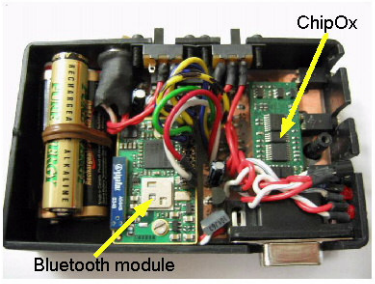

Fig. 1. Realized pulse oximeter.

The second chose OEM module is module ECG 100 from MCC Company. It is created for electrocardiography with standard bipolar limbs leads. It can communicate by UART protocol. It sends to host device values of II and III Einthoven leads. Measured pulse frequency range is between 30 and 245 beats per second and it is measured as sliding average from last eight measured values. Module can detect pacemaker impulses and when leads are not connected.

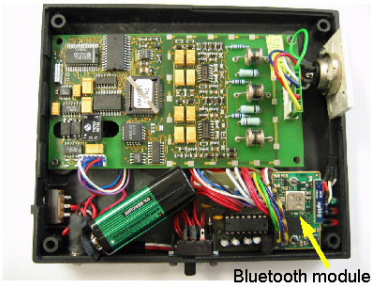

Fig. 2. Realized ECG.

For blood pressure measuring was used blood pressure monitor UA-767PC, which include standard serial interface. This interface was used for Bluetooth communication too. The Bluetooth module was connected to that interface. It was necessary to connect Bluetooth module to serial connector and provide power supply. The blood pressure monitor can save measured values from last 126 measurements. It is saving these four basic values: systolic pressure, diastolic pressure, pulse frequency and time. It is possible to start a new measuring by defined command from connected computer too. In this case the monitor sends to computer measured values immediately after end of measuring process.

Fig. 3. Blood pressure monitor.

Bluetooth module, which was chosen for realisation Bluetooth communication, can be used as a component in many types of systems allowing them to communicate wirelessly with other Bluetooth products such as PC-cards, laptops, handheld computers and mobile phones. It allows with an RS232 port or UART interface to communicate wirelessly via Bluetooth with other Bluetooth devices. The module can be configured using the Windows based configuration wizard or using AT commands. It supports Generic access profile, Serial port profile, Dial-up profile and LAN access profile. The module is qualified according to the Bluetooth 1.1 specification. Next function of this module is Wireless multidrop. This feature allows the module to simultaneously communicate with up to three remote Bluetooth devices depending on application and cases. The module automatically forms a wireless multidrop network and distributes all data to all connected devices.

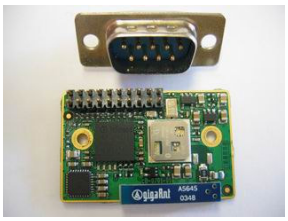

Fig. 4. Used Bluetooth module.

3. TREATMENT

The first was tested communication between referenced devices and computer by standard serial line. It was good for test of functionality of devices and ability of communication. Then can be designed, realized and tested Bluetooth communication. The first it was point-to-point communication afterwards the point-to-multipoint communication. It was created wireless network of all referenced devices.

It is necessary to set up correct communication protocol of serial communication between device (computer) and Bluetooth module the first. Afterwards could be set up the parameters of Bluetooth communication.

At the basic settings were set up name of Bluetooth device and selected possibility to set up the Bluetooth parameters by Bluetooth. Next was selected operation mode connectable and discoverable. The other devices can connect to it and it can be found when other devices are performing searches. It was necessary to decide on a client or a server role of Bluetooth module. Used Bluetooth modules can be set up client and the server at the same time. It is very profitable at point-to-point communication.

For point-to-point communication were designed three versions of Bluetooth communications parameters. Referenced Bluetooth modules at the computer and device side realized the Bluetooth communication too.

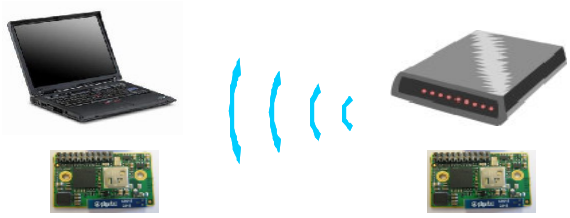

Fig. 5. Point-to-point communication.

For point-to-multipoint communication was possible to use on computer side USB Bluetooth dongle or referenced Bluetooth module and its function for creating point-to-multipoint network - Wireless multidrop. But after tests it was clear that this function (Wireless multidrop) isn't accordant with engaged wants. As a consequence was chosen USB Bluetooth dongle BT-600 from ACER Company. This USB dongle can work by standard driver for Bluetooth communications included in operating system WindowsXP (2nd service pack). This driver provides to create more than one virtual serial port.

The first was tested point-to-point communication between computer with USB Bluetooth dongle and measuring devices via Bluetooth. Afterwards was designed and realized point-to-multipoint connection between referenced USB Bluetooth dongle and all other referenced devices. After the far devices with Bluetooth module were found by the USB Bluetooth dongle (more precisely by drivers in operating system), were these devices added to list of Bluetooth devices. Each of found devices gets own virtual serial port. In the visualisation software, which was created too, was set up only correct name of virtual serial port for each device, and communication could start.

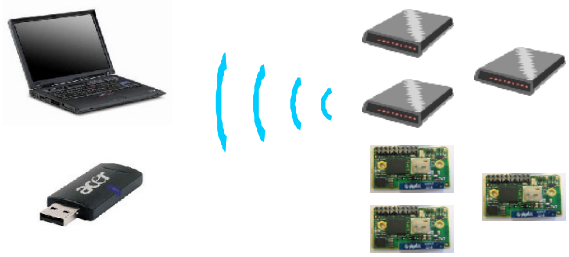

Fig. 6 . Point-to-multipoint communication.

Part of this work is the software for visualisation and saving measured data too. This software, named BIOMONITOR is developed in development system Labview from National instruments, version 6.1. The most important demands were easy intuitive control and very good lucidity of user interface.

It was designed and realized user interface, where each group of measured values has own colour of chart or more precisely colour of background. The part of final software is the Terminal too. Terminal allows to user select, which values would to measure at that time. Depending on it the user interface is changed and user can see only that charts and groups of indicators, which are need to indicate measured data.

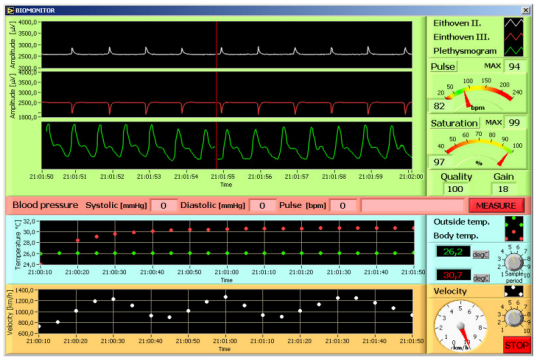

Fig. 7. BIOMONITOR user interface.

Displayed version of software is suited for visualisation values which are measured in frame of project of Biomedical laboratory VSB-TU Ostrava: Biotelemetry system of pilot for Shell Eco – Marathon.

4. RESULTS

It was realized wireless network of medical devices. The network was realized by Bluetooth technology. For Bluetooth communication was used Bluetooth modules created for serial cable replacement on the device side. On the computer side was used USB Bluetooth dongle. All the system is mobile and can be used in every computer, which can cooperate with USB Bluetooth dongle. It can be used in computer which include anything else for realize Bluetooth communication. Accumulators can supply realized devices. It is very good, because such devices are flexible and mobile.

It was created software for visualisation and saving measured data. Software is very easy to control and it is very well designed. Software displays all the measured data at the time. The values measured at the analog inputs of ChipOx module are displayed and saved too.

5. CONCLUSIONS

The results of this work can be used in implementation of wireless communication in branch of medical technique. Realized network of devices can be used in many applications of telemedicine, mainly as the system of monitoring base life functions. This network can be used in the field of telemonitoring for example long ill people, elderly people and other.

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